



## DEPARTMENT OF TRANSPORTATION

MATERIALS TRANSPORTATION BUREAU

WASHINGTON, D.C. 20590

54097

### Research and Special Programs Administration

49 CFR Parts 171, 173, 178

[Docket No. HM-176; Notice No. 80-7]

### Specification and Usage Requirements for New DOT 3AL Seamless, Aluminum Cylinders

**AGENCY:** Materials Transportation Bureau (MTB), Research and Special Programs Administration, D.O.T.

**ACTION:** Notice of proposed rulemaking.

**SUMMARY:** The MTB proposes to amend the Department's Hazardous Materials Regulations to establish a new specification for aluminum cylinders and to authorize use of these cylinders for certain hazardous materials. A proposed new § 178.46 would contain the specification for the new 3AL aluminum cylinder which, basically, would be constructed in accordance with recommended specifications contained in two petitions for rulemaking and the requirements specified in existing exemptions for aluminum cylinders. This proposed rule change would provide for greater acceptance of aluminum cylinders by purchasers and would terminate six exemptions authorizing use of over 1,000,000 cylinders.

**DATE:** Comments must be received November 1, 1980.

**ADDRESS:** Comments must be addressed to the Dockets Branch, Materials Transportation Bureau, U.S. Department of Transportation, Washington, D.C. 20590 (phone (202) 426-3148). Comments should identify the docket and be submitted, if possible, in five copies. The Dockets Branch is located in Room 8426 of the Nassif Building, 400 7th Street, S.W., Washington, D.C. Office hours are 8:30 a.m. to 5 p.m., Monday thru Friday.

**FOR FURTHER INFORMATION CONTACT:** Arthur Mallen, Chief, Technology Division, Office of Hazardous Materials Regulation, Materials Transportation Bureau, U.S. Department of Transportation, Washington, D.C. 20590 (202-755-4906).

**SUPPLEMENTARY INFORMATION:** This proposed rule is based in part on the Compressed Gas Association's (CGA) petition dated November 3, 1973, and Airco Industrial Gases' (AIG) petition dated April 2, 1979, to add a new high pressure aluminum cylinder specification to Part 178. The proposed

rule differs from the petitioners' requests on the following points.

### Qualification, Maintenance and Filling of Cylinders

The applicable requirements pertaining to usage, maintenance, qualification and requalification of aluminum cylinders proposed by the petitioners are similar to current requirements specified for DOT 3A and DOT 3AA cylinders. This proposal modified the requests of the petitioners by incorporating certain requirements specified in existing aluminum cylinder exemptions (DOT-E 8498, 8587, 8688, 7042, 7941 and 8384) as follows:

(1) Since data on compatibility with aluminum is limited or nonexistent for some of the materials authorized in the exemptions and for many materials authorized for shipment in DOT 3A and DOT 3AA cylinders, the MTB proposes to allow only those materials authorized in existing exemptions for which satisfactory compatibility data are available to be charged and shipped in the proposed aluminum cylinders.

(2) Because of the lack of supporting retest data for aluminum cylinders, a ten year retest frequency (49 CFR 173.34(e)(11), (14), and (15)) and a visual inspection in lieu of a hydrostatic retest (49 CFR 173.34(e)(10)) would not be authorized. This matter will be addressed in a future rulemaking action when sufficient retest data has been accumulated to support such an action. The MTB invites public participation in the accumulation of this data.

(3) A "rejection elastic expansion" which is used as "service control" for DOT 3A and 3AA cylinders charged in accordance with 49 CFR 173.302(c) is not available for aluminum cylinders. Therefore, filling of aluminum cylinders would be limited to 100 per cent of the marked service pressure.

(4) When used in oxygen service, aluminum cylinders would be required:

- (a) To have straight threads only;
- (b) To have a marked service pressure not exceeding 3000 psi; and
- (c) To be cleaned in compliance with Federal Specification RR-C-901b in order to remove contaminants that would support ignition.

(5) Due to the absence of industry justification and the lack of information on the compatibility of aluminum with certain hazardous materials listed in Part 173, manifolding of aluminum cylinders would not be authorized.

### Specification for Aluminum Cylinders

The specification for aluminum cylinders in this proposed rule varies from the petitioners' proposals as follows:

(1) The MTB is proposing that inspections be performed by independent inspection agencies approved in accordance with §§ 173.300a or 173.300b. The duties of the inspector would be clarified so that certain specified tests must be witnessed or performed by the inspector, and certain quality controls using documented data must be verified by the inspector.

(2) To assure compliance with the material specification, the inspector, material producer or cylinder manufacturer would be required:

(a) To perform a chemical analysis on each melt or cast of material;

(b) To obtain a certified chemical analysis from the material manufacturer for each melt of material; or,

(c) To perform a check analysis on one cylinder out of each lot of 200 cylinders or less in lieu of a certified chemical analysis a certificate indicating compliance with the material specification is obtained.

(3) In this proposal "Reporting volumetric capacity and tare weight" is not included in the listing of specific duties of the inspector (§ 178.46-4(d)). A specific listing of this duty is considered unnecessary since it would be performed in the process of fulfilling item (10) of 178.46-4(d)—"Preparing and providing the required report to the purchaser, cylinder maker, and the Associate Director for OE."

(4) A definition of a "lot" size, and "significant design change" would be provided.

(5) Starting material would be required to be traceable to cast stock and would be required to have uniform equiaxed grain structure not exceeding 250 microns average.

(6) The acceptable results obtained from certain physical and mechanical properties tests would be restricted to standards which are consistent with properties of cylinders manufactured under existing exemptions as follows:

(a) The elongation requirements would be changed from 10 percent to 14 percent using a 4D bar or 2 inch gauge length test specimen.

(b) The flattening test would be changed from 10t to 2t, and

(e) The minimum burst pressure would be increased from 2.3 to 2.5 times the marked service pressure; failure would be required to initiate in the sidewall; and the failed cylinder would be required to remain in one piece.

(7) An internal bottom knuckle radius of 12 percent of the inside diameter of the cylinder would be specified to minimize stress concentrations created by the transition from sidewall to bottom of the cylinder.

(8) The requirement for openings would be patterned after the more specific requirements in 49 CFR 178.45.

(9) Cylinders containing certain hazardous materials would be required to be packaged in strong outside packagings for proper protection of valves, safety devices or other connections.

(11) The flattening test procedure and the test result would be revised for consistency with current manufacturing practice. An acceptable level for failure would be specified for test results. An alternate bend test using an appropriately sized mandrel in lieu of performance of a flattening test would be authorized.

(12) As required by the regulations for other cylinder specifications, the symbol of the maker would be required to appear on the cylinder.

(13) The proposed rule would require an inspector to report the following additional information:

(a) the temper designation, along with the alloy designation, of the material;

(b) The flattening test result as a multiple of the actual sidewall thickness; and

(c) The design and the actual minimum thickness of the sidewall.

(14) The proposed rule would set the cyclic pressurization rate for the design qualification test at not more than 10 cycles per minute. In the absence of test data there is concern that a faster rate of cycling would not allow adequate time for the cylinder metal to fully respond to the stress reversals.

Cylinders determined to be in full compliance with the requirements specified in an exemption will be allowed to be re-marked with the appropriate cylinder specification number.

In addition to receiving comments on the other issues in this proposal, the MTB is taking the opportunity to solicit comments on hazardous materials being shipped in aluminum cylinders. Comments should address or provide information on the following:

(1) A listing of materials actually shipped under exemption or other authority indicating the quantity shipped by cylinders, in cubic feet (gas), gallons

(liquid) or some other unit of measurement along with a listing of the sources from which the compatibility data was derived such as shipping experience, tests, etc.

(2) Data to support or refute the 3000 psi service pressure limitation for aluminum cylinders in oxygen service.

(3) Data on the compatibility of aluminum with other hazardous materials not authorized in this proposed rule.

There are certain hazardous materials and conditions in which they are shipped that are in need of further evaluation to justify authorization for their use in aluminum cylinders such as those listed below:

(1) *Cylinders charged with poison A liquid or gas.*

(a) *Pressure Relief Devices.*—Section 173.34(d) prohibits the use of pressure relief devices on steel DOT specification cylinders charged with Poison A gas and liquid. The use of a pressure relief device is prohibited because it has been determined that poisonous materials must be contained to the maximum extent possible under all conditions. This prohibition is intended to provide the maximum safeguard against leakage under normal transportation conditions, in addition to maintaining the maximum possible duration of containment in a fire situation. For these materials, containment of the contents up to burst pressure of the cylinder is considered a lesser risk than that of releasing the contents at pressure relief device settings, even though there is a chance of cylinder failure.

(b) In addition to delaying the release of hazardous materials until cylinder failure occurs by prohibiting the use of a pressure relief device, further delay of such release is accomplished by lengthening the time to cylinder failure by limiting the filling pressure at 70° F. to a pressure less than the marked service pressure (see § 173.337(a)(1)). Consideration, then must be given to the filling pressure limits at 70° F. for aluminum cylinders to equate the time to release (cylinder failure) of the hazardous material to no less than the time to release for steel cylinders currently specified.

(2) *Aluminum cylinders charged with fluorine and other strong oxidizers.*

Fluorine and other strong oxidizers have been compatible with the steel cylinders currently authorized. These same materials are considered compatible with aluminum at ambient temperatures; however, evaluations must be made to determine if elevated temperatures such as in a fire situation change the compatibility of these hazardous materials with aluminum.

The compatibility is to be determined using steel cylinders as the criteria.

(3) *Pressure limitations for certain hazardous materials.*

Cylinders charged with carbon monoxide and other gaseous materials are currently required to be filled at pressures less than the marked service pressure. Some of the reasons for this requirement are the reactions between the hazardous materials and the cylinder material, reactions between impurities in the hazardous material and the cylinder material (See § 173.301(f) and (g)), and a concern for the release of toxic materials if charged to the marked service pressure, as discussed in paragraph (1)(a) above.

It is requested that comments and meaningful data be supplied on these and other similar hazardous materials and their shipping state to provide the information necessary to determine the conditions that must be imposed and the acceptability of the aluminum cylinder for shipment of these materials. In developing the comments and data, the following should be taken into consideration.

1. Elevated temperature data (to include fire conditions) for cylinders without a pressure relief device to determine steel and aluminum cylinder failure levels at various temperatures and developed pressures for:

a. Liquids (poison A)

b. Liquefied gases (poison A)

c. Nonliquefied gas (poison A)

2. Effect of varying filling pressures at elevated temperatures to reach comparability with steel cylinders for the same materials listed above.

3. Elevated temperature reaction data for steel and aluminum cylinders filled with oxidizers currently authorized to be shipped in steel cylinders.

4. Corrosion or other reaction data for hazardous materials currently required to be shipped at pressures less than the cylinder marked service pressure.

The cylinder marking requirements proposed in this notice at § 178.46-15 are not fully consistent with the revised marking requirements proposed under Docket HM-172; Notice 80-2 (45 FR 9960) published on February 14, 1980. The MTB's consideration of final regulations under this rulemaking will take into account its decision concerning final regulations under Docket HM-172.

Primary drafters of this document are Arthur J. Mallen, Paul H. Seay, Jose Pena, Hattie Mitchell, Office of Hazardous Materials Regulation, MTB, and Douglas A. Crockett, Office of the Chief Counsel, Research and Special Programs Administration.

In consideration of the foregoing, it is proposed to amend Parts 171, 173, and

178 of Title 49 Code of Federal Regulations as follows:

**PART 171—GENERAL INFORMATION, REGULATIONS AND DEFINITIONS**

1. In § 171.7, paragraphs (d)(5)(x), (xi) and (xii), and (d)(23) would be added, paragraph (d)(19) would be revised to read as follows:

**§ 171.7 Matter incorporated by reference.**

(d) \* \* \*

(5) \* \* \*

(x) ASTM E-8-79 is titled "Standard Methods of Tension Testing of Metallic Materials," 1979 edition.

(xi) ASTM B-221-76 is titled "Standard Specification for Aluminum Alloy Extruded Bars, Rods, Shapes and Tubes," 1976 Edition.

(xii) ASTM E 290-77 is titled "Semi-Guided Bend Test for Ductility of Metallic Materials," 1977 edition.

(19) Federal Specification RR-C-801b is titled "Federal Specification, Cylinders, Compressed Gas: With Valve or Plug and Cap; ICC 3AA RR-C-801b, August 1, 1967."

(23) Aluminum Associations' Handbook is titled "Aluminum Standards and Data," Sixth Edition, 1979.

**PART 173—SHIPPERS—GENERAL REQUIREMENTS FOR SHIPMENTS AND PACKAGINGS**

2. In § 173.34, the Table in paragraph (e) would be amended by adding an entry "3AL" immediately following the entry "3A, 3AA"; paragraphs (e)(4) and (f)(4) would be revised, to read as follows:

**§ 173.34 Qualification, maintenance and use of cylinders.**

(e) \* \* \*

Specification under which cylinder was made	Minimum retest pressure (pounds per square inch)	Retest period (years)
3AL	5/3 times service pressure	5

(4) A cylinder must be condemned when it leaks, or when internal or external corrosion, denting, bulging, or evidence of rough usage exists to the extent that the cylinder is likely to be weakened appreciably, or when the permanent expansion exceeds 10 percent of the total expansion, except that for DOT 4E aluminum cylinders, when the permanent expansion exceeds 12 percent of the total expansion. Except for DOT 3AL and DOT 4E aluminum cylinders, a cylinder condemned for excessive permanent expansion may be reheat-treated. (See paragraph (g) of this section.) DOT 4 series cylinders, condemned for other than excessive permanent expansion, may be repaired and rebuilt as otherwise provided in this section.

(f) \* \* \*

(4) DOT 3AL and DOT 4E aluminum cylinders may not be reheat-treated and must be removed from service.

3. In § 173.119, paragraphs (a)(11), (f)(2) and (m)(9) would be revised to read as follows:

**§ 173.119 Flammable liquids not specifically provided for.**

(a) \* \* \*

(11) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene.

(f) \* \* \*

(2) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene.

(m) \* \* \*

(9) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene. All cylinder valves must be protected by one of the methods described in § 173.301(g) (1), (2), or (3) of this part. See § 173.34(e)(16).

4. In § 173.123, paragraph (a)(4) would be revised to read as follows:

**§ 173.123 Ethyl chloride.**

(a) \* \* \*

(4) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene.

5. In § 173.124, paragraph (a)(2) would be revised to read as follows:

**§ 173.124 Ethylene oxide.**

(a) \* \* \*

(2) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene. All cylinders must be seamless or welded, and may not exceed 30 gallons nominal water capacity. Cylinders must be equipped with safety devices of the fusible plug type with threaded straight bore orifice and with yield temperature of 157° to 170° F. having a minimum vent area of 0.0055 square inch per pound of water capacity for cylinders not over 1-gallon capacity and 0.0012 square inch per pound of water capacity for all cylinders over 1-gallon capacity. Each cylinder must be tested for leakage at a pressure of at least 15 psig with an inert gas before each refilling. Filling must be such that the cylinder will not be liquid full at 185° F. Pressurizing valves must be provided for all cylinders over 1-gallon capacity. Educator tubes must be provided for all cylinders over 5-gallon capacity. Cylinders having a water capacity in excess of 1 gallon must be insulated with at least three coats of heat-retardant paint, of a type examined by the Bureau of Explosives and approved by the Associate Director for OE, applied over suitable primer and finished with suitable waterproof paint; or with other equally efficient insulation examined by the Bureau of Explosives and approved by the Associated Director for OE.

6. § 173.126 would be revised to read as follows:

**§ 173.126 Nickel carbonyl.**

Nickel carbonyl must be packed in specification steel or nickel cylinders as prescribed for any compressed gas except acetylene. A cylinder used exclusively for nickel carbonyl may be given a complete external visual inspection in lieu of the interior hydrostatic pressure test required by § 173.34(e) of this part. Visual inspection must be in accordance with CGA Pamphlet C-6.

7. In § 173.134, paragraph (a)(1) would be revised to read as follows:

**§ 173.134 Pyrophoric liquids, n.o.s.**

(a) \* \* \*

(1) Except for acetylene cylinders, any steel or nickel cylinder prescribed for any compressed gas having a minimum design pressure of 175 pounds per square inch is authorized. Cylinders with valves must be:

8. In § 173.135, paragraph (a)(6) would be revised to read as follows:

§ 173.135 Diethyl dichlorosilane, dimethyl dichlorosilane, ethyl dichlorosilane, ethyl trichlorosilane, methyl trichlorosilane, trimethyl chlorosilane, and vinyl trichlorosilane.

(a) \* \* \*

(6) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene.

9. In § 173.136, paragraph (a)(5) would be revised to read as follows:

§ 173.136 Methyl dichlorosilane and trichlorosilane.

(a) \* \* \*

(5) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene.

10. In § 173.137, paragraph (a)(9) would be revised to read as follows:

§ 173.137 Lithium aluminum hydride, etheral.

(a) \* \* \*

(3) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene. Valves or fittings must be protected from injury by a metal cap or equally efficient device securely attached to the cylinder.

11. § 173.138 would be revised to read as follows:

§ 173.138 Pentaborane.

Except for acetylene cylinders, any steel or nickel cylinder prescribed for any compressed gas is authorized. Each cylinder must be protected with a valve protection cap or must be packed in a strong wooden box and blocked therein so as to protect the valve from injury under conditions normally incident to transportation. Cylinders not exceeding 2 inches in diameter nor 6 inches in length, excluding the length of the valve, may also be packed in strong solid fiberboard boxes, having no outside dimension less than 4 inches, completely filled with layers of strong corrugated fiberboard, the center of which shall be cut out to fit the cylinder valve, and otherwise so designed that neither the cylinder nor the valve will be in contact with the wall of the box under conditions normally incident to transportation.

12. In § 173.141, paragraph (a)(9) would be revised to read as follows:

§ 173.141 Amyl mercaptan, butyl mercaptan, ethyl mercaptan, isopropyl mercaptan, propyl mercaptan, and aliphatic mercaptan mixtures.

(a) \* \* \*

(9) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene.

13. In § 173.148, paragraph (a)(2) would be revised to read as follows:

§ 173.148 Monoethylamine.

(a) \* \* \*

(2) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene.

14. In § 173.245, paragraph (a)(28) would be revised to read as follows:

§ 173.245 Corrosive liquids not specifically provided for.

(a) \* \* \*

(28) Except for acetylene cylinders, any steel or nickel cylinder prescribed for any compressed gas is authorized. All cylinder valves must be protected by one of the methods described in § 173.301(g)(1), (2), or (3) of this part. See § 173.34(e)(16).

15. In § 173.251, paragraph (a)(1) would be revised to read as follows:

§ 173.251 Boron trichloride and boron tribromide.

(a) \* \* \*

(1) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene.

16. In § 173.280, paragraph (a)(6) would be revised to read as follows:

§ 173.280 Trichlorosilanes.

(a) \* \* \*

(6) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene.

17. In § 173.301, paragraphs (d)(2) and (3) would be revised; the Table in paragraph (h) would be amended by adding the entry "3AL" immediately following the entry "DOT3A," as follows:

§ 173.301 General requirements for shipment of compressed gases in cylinders.

(d) \* \* \*

(2) Specification steel or nickel cylinders containing the following nonliquefied gases may be manifolded: boron trifluoride, carbon monoxide, ethylene, hydrogen, hydrocarbon gases, methane, and nitrogen trifluoride, provided individual cylinders are equipped with approved safety relief devices as required by § 173.34(d) or § 173.315(i) of this part: and provided further, that each cylinder is equipped

with an individual shutoff valve that must be tightly closed while in transit. Manifold branch lines of these individual shutoff valves must be sufficiently flexible to prevent injury to the valves which otherwise might result from the use of rigid branch lines. A temperature measuring device may be inserted in one cylinder of a manifold installation in place of the shutoff valve.

(3) Specification steel or nickel cylinders containing the following gases may be manifolded: ethane, ethylene, liquefied hydrocarbon gas, hydrogen chloride (anhydrous), liquefied petroleum gas and propylene provide each cylinder is equipped with approved safety relief devices as required by § 173.34(d) or § 173.315(i) of this part: and provided further, that each cylinder is equipped with an individual shutoff valve that must be tightly closed while in transit. Each cylinder must be separately charged and means must be provided to insure that no interchange of cylinder contents can occur during transportation. Manifold branch lines to these individual shutoff valves must be sufficiently flexible to prevent injury to the valves which otherwise might result from the use of rigid branch lines.

(h) \* \* \*

#### Cylinders

DOT 3AL

\* \* \* \* \*

18. In § 173.302, paragraph (a)(4)(iii) would be revised; a new paragraph (a)(5) would be added; and paragraph (f) would be revised to read as follows:

§ 173.302 Charging of cylinders with nonliquefied compressed gases.

(a) \* \* \*

(4) \* \* \*

(iii) Each cylinder must be cleaned and tested for oil contamination in compliance with the requirements of Federal Specification RR-C-901b, paragraphs 3.7.2, 3.8.2 and 4.4.2.3. One cylinder selected at random from each lot of 200 or less must be tested and meet the standard of cleanliness specified.

(5) Specification 3AL (§ 178.48 of this subchapter) cylinders are authorized only for the following nonliquefied gases: air, argon, carbon monoxide, helium, hydrogen, krypton, methane, nitrogen, neon, oxygen and xenon. When used in oxygen service, aluminum cylinders must be in compliance with the following conditions:

- (i) Cylinder must be equipped only with brass valves;
  - (ii) Cylinder must have only straight threads in the opening;
  - (iii) Each cylinder must be cleaned and tested for oil contamination in compliance with the requirements of Federal Specification RR-C-901b, paragraphs 3.7.2, 3.8.2 and 4.4.2.3. One cylinder selected at random from each lot of 200 or less must be tested and meet the standard of cleanliness specified; and
  - (iv) Cylinder must have a marked service pressure not exceeding 3,000 psi.
- \*\*\*
- (f) Carbon monoxide. Carbon monoxide must be shipped in a specification 3A, 3AX, 3AA, 3AAX, 3AL,

3, 3E, or 3T, (§§ 178.36, 178.37, 178.46, 178.42, 178.45 of this subchapter) cylinder having a minimum service pressure of 1,800 psig. The pressure in the cylinder must not exceed 1,000 psig at 70°F, except that if the gas is dry and sulfur free, the cylinder may be charged to five-sixths of the cylinder service pressure or 2,000 psig, whichever is the lesser.

19. In § 173.304, paragraphs (a)(1) and (d)(3)(i) would be revised; the table in paragraph (a)(2) would be revised to authorize DOT 3AL cylinders with various service pressures for certain commodities as follows:

**§ 173.304 Charging of cylinders with liquefied compressed gases.**

(a) \* \* \*

(1) Specifications 3, 3A, 3AA, 3AL, 3B, 3BN, 3D, 3E, 4, 4A, 4B, 4BA, 4B-ET, 4BW, 4E, 9, 25, 26, 38, 39, 40, 41, (§§ 178.36, 178.37, 178.46, 178.38, 178.39, 178.41, 178.42, 178.48, 178.49, 178.50, 178.51, 178.55, 178.61, 178.65, 178.68 of this subchapter), cylinders except that no specification 3AL, 9, 39, 4E, 40, or 41 cylinders may be charged and shipped with a mixture containing a pyrophoric liquid, carbon bisulfide (disulfide), ethyl chloride, ethylene oxide, nickel carbonyl, spirits of nitroglycerin, or poisonous material (class A, B, or irritating material), unless specifically authorized in this part.

(2) \* \* \*

Kind of gas	Maximum permitted filling density (see note 1)	Containers marked as shown in this column or of the same type with higher service pressure must be used except as provided in § 173.34 (a), (b), § 173.301(f) (see notes following table)
Anhydrous ammonia.....	54 pct.....	DOT-4; DOT-3A480; DOT-3AA480; DOT-3A480X; DOT-4A480; DOT-3; DOT-4AA480; DOT-3E1800; DOT-3AL480.
3A/ Carbon dioxide, liquefied (See Notes 4, 7, and *).....	68 pct.....	DOT-3A1800; DOT-3AX1800; DOT-3AA1800; DOT-3AAX1800; DOT-3; DOT-3E1800; DOT-3T1800; DOT-3HT2000; DOT-39; DOT-3AL1800.
Carbon dioxide-nitrous oxide mixture (See Notes 7 and *).....	68 pct.....	DOT-3A1800; DOT-3AX1800; DOT-3AA1800; DOT-3AAX1800; DOT-3; DOT-3E1800; DOT-3T1800; DOT-3HT2000; DOT-39; DOT-3AL1800.
Cyclopropane (See Notes 8 and 9).....	65 pct.....	DOT-3A225; DOT-3A480X; DOT-3AA225; DOT-3B225; DOT-4A225; DOT-4AA480; DOT-4B225; DOT-4BA225; DOT-4BW225; DOT-4B240ET; DOT-3; DOT-3E1800; DOT-39; DOT-3AL225.
Dichlorodifluoromethane (See Note 8).....	119 pct.....	DOT-3A225; DOT-3AA225; DOT-3B225; DOT-4A225; DOT-4B225; DOT-4BA225; DOT-4BW225; DOT-4B240ET; DOT-4E225; DOT-9; DOT-19; DOT-41; DOT-3E1800; DOT-3AL225.
Dichlorodifluoromethane and difluoroethane mixture (constant boiling mixture) (See Note 8).....	Not liquid full at 130° F.....	DOT-3A240; DOT-3AA240; DOT-3B240; DOT-3E1800; DOT-4A240; DOT-4B240; DOT-4BA240; DOT-4BW240; DOT-4E240; DOT-9; DOT-39; DOT-3AL240.
Difluoroethane.....	79 pct.....	DOT-3A150; DOT-3AA150; DOT-3B150; DOT-4B150; DOT-4BA225; DOT-4BW225; DOT-3E1800; DOT-3AL150.
Difluoromonoethane (See Note 8).....	100 pct.....	DOT-3A150; DOT-3AA150; DOT-3B150; DOT-4B150; DOT-4BA225; DOT-4BW225; DOT-3E1800; DOT-39; DOT-3AL150.
Ethane (See Notes 8 and 9).....	35.8 pct.....	DOT-3A1800; DOT-3AX1800; DOT-3AA1800; DOT-3AAX1800; DOT-3; DOT-3E1800; DOT-3T1800; DOT-39; DOT-3AL1800.
Ethane (See Notes 8 and 9).....	36.8 pct.....	DOT-3A2000; DOT-3AX2000; DOT-3AA2000; DOT-3AAX2000; DOT-3T2000; DOT-39; DOT-3AL2000.
Ethylene (See Notes 8 and 9).....	31.0 pct.....	DOT-3A1800; DOT-3AX1800; DOT-3AA1800; DOT-3AAX1800; DOT-3; DOT-3E1800; DOT-3T1800; DOT-39; DOT-3AL1800.
Ethylene (See Notes 8 and 9).....	32.5 pct.....	DOT-3A2000; DOT-3AX2000; DOT-3AA2000; DOT-3AAX2000; DOT-3T2000; DOT-39; DOT-3AL2000.
Ethylene (See Notes 8 and 9).....	35.5 pct.....	DOT-3A2400; DOT-3AX2400; DOT-3AA2400; DOT-3AAX2400; DOT-3T2400; DOT-39; DOT-3AL2400.
Hydrogen sulfide (See Note 10).....	62.5 pct.....	DOT-3A480; DOT-3AA480; DOT-3B480; DOT-4A480; DOT-4B480; DOT-4BA480; DOT-4BW480; DOT-26-480; DOT-3E1800; DOT-3AL480.
Methylacetylenepropadiene, stabilized (See Note 5).....	Not liquid full at 130° F.....	DOT-4B240, without brazed seams; DOT-4BA240, without brazed seams; DOT-3A240; DOT-3AA240; DOT-3B240; DOT-3E1800; DOT-4B240; DOT-4E240; DOT-4B240ET; DOT-4; DOT-41; DOT-3AL240.
Monochlorodifluoromethane (See Note 8).....	105 pct.....	DOT-3A240; DOT-3AA240; DOT-3B240; DOT-4B240; DOT-4BA240; DOT-4BW240; DOT-4B240 ET; DOT-4E240; DOT-39; DOT-41; DOT-3E1800; DOT-3AL240.
Monochloropentafluoroethane (See Note 8).....	110 pct.....	DOT-3A225; DOT-3AA225; DOT-3B225; DOT-4A225; DOT-4B225; DOT-4BA225; DOT-4BW225; DOT-3E1800; DOT-39; DOT-3AL225.
Monochlorotrifluoromethane (See Note 8).....	100 pct.....	DOT-3A1800; DOT-3AA1800; DOT-3; DOT-3E1800; DOT-39; DOT-3AL1800.
re/ Sulfur dioxide (See Note 8).....	125 pct.....	DOT-3A225; DOT-3AA225; DOT-3B225; DOT-4A225; DOT-4B225; DOT-4BA225; DOT-4BW225; DOT-4B240ET; DOT-3; DOT-4; DOT-25; DOT-26-150; DOT-38; DOT-39; DOT-3E1800; DOT-3AL225.
Sulfur hexafluoride.....	120 pct.....	DOT-3A1000; DOT-3AA1000; DOT-3; DOT-3E1800; DOT-3AL1000.

Kind of gas	Maximum permitted filling density (see note 1)	Containers marked as shown in this column or of the same type with higher service pressure must be used except as provided in § 173.34 (a), (b), § 173.301(f) (see notes following table)
Vinyl chloride (See Note 5)	84 pct.	DOT-4B150, without brazed seams; DOT-4BA225, without brazed seams; DOT-4BW225; DOT-3A150; DOT-3AA150; DOT-25; DOT-3E1800; DOT-3AL150.

(d) \* \* \*

(8) \* \* \*

(f) Specification 3, 3A, 3AA, 3AL, 3B, 3E, 4, 4A, 4B, 4BA, 4B240FLW, 4B240ET, 4BW, 4B240X, 4E, 9, 25, 26, 38, 39, or 41<sup>1</sup> (§§ 178.36, 178.37, 178.46, 178.38, 178.42, 178.48, 178.49, 178.50, 178.51, 178.54, 178.55, 178.61, 178.68, 178.65, of this subchapter) cylinders. The internal volume of a specification 39 cylinder must not exceed 75 cubic inches.

20. In § 173.346, paragraph (a)(11) would be revised to read as follows:

§ 173.346 **Poison B liquids not specifically provided for.**

(a) \* \* \*

(11) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene.

21. In § 173.354, paragraph (a)(3) would be revised to read as follows:

§ 173.354 **Motor fuel antiknock compound or tetraethyl lead.**

(a) \* \* \*

(3) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene.

22. In § 173.358, paragraph (a)(7) would be revised to read as follows:

§ 173.358 **Hexaethyl tetraphosphate; methyl parathion; organic phosphate compound; organic phosphorous compound; parathion; tetraethyl dithio pyrophosphate; and tetraethyl pyrophosphate, liquid.**

(a) \* \* \*

(7) Specification steel or nickel cylinders as prescribed for any compressed gas except acetylene.

23. In § 173.382, paragraph (a)(4) would be revised to read as follows:

§ 173.382 **Irritating materials, not specifically provided for.**

(a) \* \* \*

Except for acetylene cylinders, any steel or nickel cylinder prescribed for any compressed gas is authorized. These cylinders must be qualified, maintained, and filled in accordance with §§ 173.34 and 173.301(g) of this part. If used for material with vapor pressures exceeding 25 psig at 70° F., they must also be retested as required by § 173.34(e).

## PART 178—SHIPPING CONTAINER SPECIFICATIONS

24. The Table of Sections to Subpart C, Part 178 would be amended by adding an entry for § 178.46 to read as follows:

§ 178.46 Specification 3AL; seamless cylinders made of definitely prescribed aluminum alloys.

25. § 178.46 would be added to read as follows:

§ 178.46 **Specification DOT-3AL; seamless cylinders made of definitely prescribed aluminum alloys.**

### § 178.46-1 Compliance.

Each specification DOT 3AL seamless cylinder must comply with this section and § 173.24 of this subchapter.

### § 178.46-2 Size and service pressure.

- The maximum water capacity is 1000 pounds.
- The minimum service pressure is 150 psi (see § 173.300(h) of this subchapter).

### § 178.46-3 Inspection.

Inspections and verifications must be performed by an independent inspection agency approved in writing by the Associate Director for OE in accordance with § 173.300a of this subchapter. Chemical analyses and tests as specified must be made within the United States unless otherwise approved in writing by the Associate Director for OE in accordance with § 173.300b of this subchapter.

### § 178.46-4 Duties of the Inspector.

(a) The inspector shall determine that all materials comply with this specification before releasing those materials for cylinder manufacture.

(b) The inspector shall verify compliance with the provisions of § 178.46-5(d)(1) by:

- Performing a chemical analyses on each melt or cast or other unit of starting material;
- Obtaining a certified chemical analysis from the material manufacturer for each melt or cast of material; or
- Performing a check analysis on one

cylinder out of each lot of 200 cylinders or less, in lieu of a certified chemical analysis a certificate indicating compliance with the material specification is obtained.

(c) The inspector shall verify ultrasonic inspection of all material by inspection or by obtaining the material's producer's certificate of ultrasonic inspection. Ultrasonic inspection must be performed or verified as having been performed in accordance with § 173.46-5(e).

(d) The inspector shall determine that each cylinder complies with this specification by:

- Making a complete internal inspection before closing;
- Making a complete external inspection;
- Verifying that heat treatment was proper;
- Selecting samples for all tests and check chemical analysis;
- Witnessing each test;
- Measuring the wall thickness and verifying that the prescribed minimum thickness was met;
- Verifying that the identification of material is proper;
- Verifying the threads, by gauge;
- Determining that each cylinder is marked in compliance with the specification; and
- Preparing and providing the required report to the purchaser, cylinder maker, and the Associate Director for OE.

(e) In this specification, a "lot" means a group of cylinders successively produced having the same:

- Size and configuration;
- specified material of construction;
- process of manufacture and heat treatment;
- equipment of manufacture and heat treatment; and
- Conditions of time, temperature and atmosphere during heat treatment.

In no case may the lot size exceed 200 cylinders. Any cylinder processed for use in the required destructive physical testing need not be counted as being one of the 200, but must have been processed with the lot.

**§ 178.46-5 Authorized material and  
identification of material.**

(a) Starting stock must be cast stock that is later scalped prior to extrusion of the cylinder shell. If starting stock is not cast stock, it must be traceable to scalped cast stock.

(b) Material with seams, cracks, laminations, or other defects likely to weaken the finished cylinder may not be used.

(c) Material must be identified by a suitable method that will identify the alloy, the aluminum producer's cast number, and when performed, the solution heat treat batch number during all manufacturing operations.

(d) The material must be of uniform quality. Only the following heat treatable aluminum alloys are permitted:

BILLING CODE 4910-60-M

(1) Chemical Composition Limits <sup>1/</sup>

Aluminum Association Alloy Designation Number	CHEMICAL COMPOSITION										
	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Others <sup>2/</sup>		Al
									Each	Total	
6351	0.7-1.3	0.50\Max	0.10Max	0.400.8	0.400.8		0.20Max	0.20Max	0.05Max	0.15Max.	Remainder
6061	0.40-0.8	0.7Max	0.150.40	0.15Max	0.81.2	0.040.35	0.25Max	0.15Max	0.05Max	0.15Max	Remainder

(2) Physical Property Limits

Alloy and Temper	TENSILE STRENGTH - PSI		Elongation - Percent Minimum for 2" or 4D <sup>3/</sup> Size Specimen
	Ultimate-Minimum	Yield-Minimum	
6351-T6	42,000	37,000	14
6061-T6	38,000	35,000	14

<sup>1/</sup> ASTM B 221-76 Standard Specification for Aluminum-alloy Extruded Bars, Rods, Shapes, and Tubes, Table I Chemical Composition Limits.

<sup>2/</sup> Analysis is regularly made only for the elements for which specific limits are shown, except for unalloyed aluminum. If, however, the presence of other elements is suspected to be, or in the course of routine analysis is indicated to be in excess of specified limits, further analysis is made to determine that these other elements are not in excess of the amount specified. (Aluminum Association Standards and Data - Sixth Edition 1979).

<sup>3/</sup> "D" represents specimen diameter.



(e) Before parting, all starting stock must be 100 per cent ultrasonically inspected, along the length at right angles to the central axis from two positions at 90° to one another. The equipment and continuous scanning procedure must be capable of detecting and rejecting internal defects such as cracks which have an ultrasonic response greater than that of a calibration block with a 1/4-inch diameter flat bottomed hole.

(f) Cast stock must have uniform equiaxed grain structure not to exceed 250 microns average.

(g) Any starting stock not complying with the above must be rejected.

#### § 178.46-4 Manufacture.

(a) Cylinder shells must be manufactured by the backward extrusion method and have a cleanliness level adequate to ensure proper inspection.

(b) No fissure or other defect is acceptable that is likely to weaken the finished cylinder below the design strength requirements. A reasonably smooth and uniform surface finish is required. If not originally free from such defects, the surface may be machined or otherwise conditioned to eliminate these defects.

(c) The cylinder base must have a thickness not less than the prescribed minimum wall thickness of the cylindrical shell. The interior of the base must be concave to pressure and have a basic torispherical, hemispherical, or ellipsoidal shape with the dish radius no greater than 1.2 times the inside diameter of the shell. The inside knuckle radius must not be less than 12 percent of the inside diameter of the cylindrical shell.

(d) For free standing cylinders the base thickness must be at least two times the minimum wall thickness at the juncture between the cylinder base and the floor when the cylinders are in the vertical position.

(e) Welding or brazing is prohibited.

(f) Each new design and any significant change to any acceptable design must be qualified for production by testing prototype samples as follows:

(1) Three samples must be subjected to 100,000 pressure reversal cycles between zero and service pressure or 20,000 pressure reversal cycles between zero and test pressure, at a rate not in excess of 10 cycles per minute, without failure.

(2) Three samples must be pressurized to destruction and failure must not occur at less than 2.5 times the marked cylinder service pressure. Each cylinder must remain in one piece. Failure must

initiate in the cylinder sidewall in a longitudinal direction.

(g) In this specification "significant change" means a 10 percent or greater change in cylinder design wall thickness or diameter; a 20 percent or greater change in length, service pressure or rated capacity; and any change in material.

#### § 178.46-7 Wall thickness.

(a) The minimum wall thickness must be such that the wall stress at the minimum specified test pressure may not exceed 80 per cent of the minimum yield strength and may not exceed 87 per cent of the minimum ultimate tensile strength as verified by physical tests in § 178.46-13.

(b) Calculations must be made by the formula:

$$S = [P(1.3D^2 + 0.4d^2)] / [D^2 - d^2 - d^2]$$

Where:

S = wall stress in pounds per square inch;

P = prescribed minimum test pressure in pounds per square inch (see § 178.46-11(c));

D = outside diameter in inches;

d = inside diameter in inches.

(c) The minimum wall thickness for any cylinder with an outside diameter greater than 5 inches must be 0.125 inch.

#### § 178.46-8 Openings.

(a) Openings are permitted in heads only.

(b) The size of any centered opening in a head may not exceed one-half the outside diameter of the cylinder.

(c) Other openings are permitted in the head of a cylinder if:

(i) Each opening does not exceed 2.625 inches in diameter, or one-half the outside diameter of the cylinder;

(ii) Each opening is separated from each other by a ligament; and

(iii) Each ligament which separates two openings must be at least three times the average of the diameters of the two openings.

(d) All openings must be circular.

(e) All openings must be threaded.

Threads must comply with the following:

(1) Each thread must be clean cut, even, without any checks, and to gauge.

(2) Taper threads, when used, must be the American Standard Pipe Thread (NPT) type complying with the USDC, NBS Handbook H-28, Part III, Section VII, or the National Gas Taper Thread (NGT) standard complying with NBS Handbook H-28, Part II, Sections, VII and IX.

(3) Straight threads conforming with National Gas Straight Thread (NGS) standards are authorized. These threads must comply with NBS Handbook H-28, Part II, Section VII and IX.

#### § 178.46-9 Heat treatment.

Prior to any test, all cylinders must be subject to a solution heat treatment and aging treatment appropriate for the aluminum alloy used.

#### § 178.46-10 Safety relief devices and protection for valves, safety devices, and other connections.

Pressure relief devices and protection arrangements for valves, pressure relief devices, and other connections must comply with §§ 173.34(d) and 173.301(g) of this subchapter.

#### § 178.46-11 Hydrostatic test.

(a) Each cylinder must be subjected to an internal test pressure using the water jacket equipment and method or other suitable equipment and method. The testing apparatus must be operated in a manner so as to obtain accurate data. The pressure gauge used must permit reading to an accuracy of 1 percent. The expansion gauge must permit reading to an accuracy of 1 percent of total expansion or 0.1 cubic centimeter, whichever is greater.

(b) The test pressure must be maintained for a sufficient period of time to assure complete expansion of the cylinder. In no case may the pressure be held less than 30 seconds. If, due to failure of the test apparatus, the required test pressure cannot be maintained, the test may be repeated at a pressure increased by 10 percent or 100 psi, whichever is lower. If the test apparatus again fails to maintain the test pressure, the cylinder being tested must be rejected. Any internal pressure applied to the cylinder after heat treatment and before any official test may not exceed 90 percent of the test pressure.

(c) The minimum test pressure is the greatest of the following:

(1) 450 psi regardless of service pressure;

(2) Two times the service pressure for cylinders having service pressure less than 500 psi; or

(3) Five-thirds times the service pressure for cylinders having a service pressure of at least 500 psi.

(d) Permanent volumetric expansion may not exceed 10 percent of total volumetric expansion at test pressure.

#### § 178.46-12 Flattening test.

(a) The flattening test must be performed on one cylinder taken at random out of each lot of 200 or less by placing the cylinder between wedge shaped knife edges having a 60° included angle, and rounded in accordance with the following table. The longitudinal axis of the cylinder

must be at an angle 90° to the knife edges during the test.

Table

Cylinder wall thickness in inches	Radius in inches
Under 0.150.....	0.500
0.150 to 0.249.....	.875
0.250 to 0.349.....	1.500
0.350 to 0.449.....	2.125
0.450 to 0.549.....	2.750
0.550 to 0.649.....	3.500
0.650 to 0.749.....	4.125

(b) An alternate bend test in accordance with ASTM E 290-77 performed on two test specimens cut from a ring, using a mandrel diameter not more than 6 times the wall thickness is authorized in the following cases:

(1) When the length of the cylindrical portion of the cylinder is less than 2 times the cylinder diameter; or

(2) When the wall thickness is greater than 0.500 inch.

(c) Each test cylinder must withstand flattening to nine times the wall thickness without cracking. When the alternate bend test is used, the test specimens shall remain uncracked when bent around a mandrel in the direction of curvature of the cylinder wall, until the interior edges are at a distance apart not greater than the diameter of the mandrel.

#### § 178.46-13 Physical test.

(a) Two test specimens cut from one cylinder representing each lot of 200 cylinders or less must be tested. The results of the test must conform to at least the minimum acceptable physical property limits for aluminum alloys as specified in § 178.46-5(d)(2).

(b) Specimens must be 4D bar or gauge length 2 inches with width not over 1½-inch taken in the direction of extrusion approximately 180° from each other and tested in accordance with ASTM E-8-79. The specimen, exclusive of grip ends, may not be flattened. Grip ends may be flattened to within one inch of each end of the reduced section. When the size of the cylinder does not permit securing straight specimens, the specimens may be taken in any location or direction and may be straightened or flattened cold by pressure only, not by blows. When such specimens are used, the inspector's report must show that the specimens were so taken and prepared. Heating of specimens for any purpose is forbidden.

(c) The yield strength in tension must be the stress corresponding to a permanent strain of 0.2 percent of the gauge length.

(1) The yield strength must be determined by either the "offset" method or the "extension under load" method as prescribed in ASTM Standard E-8-79.

(2) In using the "extension under load" method, the total strain (or "extension under load") corresponding to the stress at which the 0.2 percent permanent strain occurs may be determined with sufficient accuracy by calculating the elastic extension of the gauge length under appropriate load and adding thereto 0.2 percent of the gauge length. Elastic extension calculations must be based on an elastic modulus of 10,000,000 psi. In the event of controversy, the entire stress-strain diagram must be plotted and the yield strength determined from the 0.2 percent offset.

(3) For the purpose of strain measurement, the initial strain must be set while the specimen is under a stress of 6,000 psi, the strain indicator reading being set at the calculated corresponding strain.

(4) Cross-head speed of the testing machine may not exceed ¼ inch per minute during yield strength determination.

#### § 178.46-14 Rejected cylinder.

Reheat treatment is authorized one time; subsequent thereto, cylinders must pass all prescribed tests to be acceptable.

#### § 178.46-15 Marking.

(a) Each cylinder must be plainly and permanently marked, by stamping on the cylinder shoulder, top head, or neck, in the following order)

(1) The specification marking "DOT 3AL" must appear first on the cylinder followed immediately by the service pressure (for example: DOT-3AL 1800).

(2) The serial number and an identifying symbol or letters appear next; location of the number to be just below or immediately following the DOT mark; location of the symbol to be just below or immediately following the number. The symbol and numbers must be those of the maker, or of the purchaser or user if the maker's symbol also appears near the date of the original test. The symbol must be registered with the Associate Director for O&E. No duplication is authorized. Examples:

DOT-3AL 1800  
1234

DOT-3AL1800-1234-XY.

(3) The inspector's official mark must

appear near the serial number; then the date of test (such as 5-73 for May 1973), so placed that the dates of subsequent test can be easily added.

(4) Marks must be at least ¼ inch high if space permits.

(b) Other marks are authorized provided they are made in low stress areas other than the side wall and are not of a size and depth that will create harmful stress concentrations. Such marks may not conflict with any DOT required markings.

#### § 178.46-16 Inspector's report.

(a) Required to be clear, legible, and in the following form:

Place \_\_\_\_\_  
Date \_\_\_\_\_  
Gas Cylinders:  
Manufactured for \_\_\_\_\_  
Location at \_\_\_\_\_  
Manufactured by \_\_\_\_\_  
Location at \_\_\_\_\_  
Consigned to \_\_\_\_\_  
Location at \_\_\_\_\_  
Quantity \_\_\_\_\_  
Size \_\_\_\_\_ inches outside  
diameter by \_\_\_\_\_ inches  
long  
Marks stamped into the shoulder of the  
cylinder are:  
Specification DOT \_\_\_\_\_  
Serial number \_\_\_\_\_ to \_\_\_\_\_  
\_\_\_\_\_ inclusive  
Identifying symbol (registered) \_\_\_\_\_  
Cylinder manufacturer's identification  
symbol \_\_\_\_\_  
Inspector's mark \_\_\_\_\_  
Test Date \_\_\_\_\_  
Tare weights (yes or no) \_\_\_\_\_  
Other marks (if any) \_\_\_\_\_  
These cylinders were made by process of \_\_\_\_\_

The cylinders were heat treated by the process of \_\_\_\_\_

(alloy and temper designation).

The material used was verified as to chemical analysis and record thereof is attached hereto.

All material and each cylinder were inspected; all that were accepted were found free from seams, cracks, laminations, and other defects which might prove injurious to the strength of the cylinder. The processes of manufacture and heat treatment of cylinders were supervised and found to be efficient and satisfactory.

The cylinder walls were measured and the minimum thickness noted was \_\_\_\_\_ inch. The outside diameter was determined to be \_\_\_\_\_ inches. The wall stress was calculated to be \_\_\_\_\_ pounds per square inch under an internal pressure of \_\_\_\_\_ pounds per square inch. The required minimum thickness is \_\_\_\_\_ inch and the maximum wall stress allowed is \_\_\_\_\_ pounds per square inch at an internal pressure of \_\_\_\_\_ pounds per square inch.

Hydrostatic tests, flattening tests, tensile tests of material, and other tests, as prescribed in Specification DOT-3AL were made in the presence of the inspector and all material and cylinders accepted were found to be in compliance with the specification. Records thereof are attached hereto.

I hereby certify that all of these cylinders proved satisfactory in every way and comply with the Department of Transportation Specification 3AL except as follows:  
Exceptions \_\_\_\_\_

(Signed) \_\_\_\_\_  
Inspector  
(Place) \_\_\_\_\_  
(Date) \_\_\_\_\_

BILLING CODE 4910-60-M

### RECORD OF HYDROSTATIC TESTS ON CYLINDERS

Numbered ..... to ..... inclusive.  
Size ..... inches outside diameter by .... inches long.  
Made by ..... Company

Serial Nos. of cylinders tested arranged numerically	Actual test pressure (lbs. per sq. inch)	Total expansion (cubic centi- meters) <u>1/</u>	Permanent expansion cubic centimeters) <u>1/</u>	Percent ratio of permanent expansion to total expansion (Actual value)	Tare weight (lbs) <u>2/</u>	Volumetric capacity
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....

1/ If the tests are made by a method involving the measurement of the amount of liquid forced into the cylinder by the test pressures, then the basic data on which the calculations are made, such as the pump factors, temperature of liquid, coefficient of compressibility of liquids, etc., must also be given.

2/ Do not include removable cap but state whether with or without valve. These weights must be accurate to a tolerance of 1 percent.

(Signed) .....

(Place) .....

(Date) .....

RECORD OF PHYSICAL TESTS OF MATERIAL FOR CYLINDERS

Numbered ..... to ..... inclusive.  
 Size ..... inches outside diameter by ..... inches long.  
 Made by ..... Company.  
 For ..... Company.

Test No.	Cylinders repre- sented by test (Serial Nos.)	Yield Strength at 0.2 percent offset (lbs. per sq. inch).	Tensile Strength (Pounds per sq. inch).	Elongation (Percent in _____ size speci- men)	Flattening Test (Record as multiple of t).
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....

(Signed).....

(Place).....

(Date).....

RECORD OF CHEMICAL ANALYSES OF MATERIAL FOR CYLINDERS

Numbered .....to ..... inclusive.  
 Size ..... inches outside diameter by .... inches long.  
 Made by ..... Company.  
 For ..... Company.

Note: Any omission of analyses by heats, if authorized, must be accounted for by notation hereon reading "The prescribed certificate of the manufacturer of material has been secured, found satisfactory, and placed on file," or by attaching a copy of the certificate.

Alloy Designation*	Cylinders Represented (Serial Numbers)	Chemical Analyses									
		Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Others	
										Ea.	Total
.....	.....	...	...	...	...	...	...	...	...	...	...
.....	.....	...	...	...	...	...	...	...	...	...	...
.....	.....	...	...	...	...	...	...	...	...	...	...
.....	.....	...	...	...	...	...	...	...	...	...	...

\* Aluminum Association Alloy Designation Number

The analyses were made by .....

(Signed) .....  
 (Place) .....  
 (Date) .....

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(49 U.S.C. 1803, 1804, 1808; 49 CFR 1.53, App. A to Part 1, and paragraph (a)(4) of App. A Part 106)

Note.—The Materials Transportation Bureau has determined that this document will not result in a major economic impact under the terms of Executive Order 12044 and DOT implementing procedures (44 FR 11034) nor require an environmental impact statement under the National Environmental Policy Act (49 U.S.C. 4321 et seq.). A regulatory evaluation is available for review in the docket.

Issued in Washington, D.C., on July 31, 1980.

Alan I. Roberts,

Associate Director for Hazardous Materials Regulation, Materials Transportation Bureau.

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